National Park Service-Klamath Network

Inventory and Monitoring Program

# INVENTORY SUMMARY REPORT
# FY2000-2004

By

By Sarah McCullough[1]

Contributors:
Daniel Sarr[3], Klamath Network I&M Coordinator
Bob Truitt[4], Klamath Network Data Manager
Andy Duff[3], Klamath Network GIS Specialist
Laura Bridy[2 & 3], Klamath Network Data Management Assistant

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# Author Affiliations and Addresses

1. Lassen Volcanic National Park, PO Box 100, Mineral CA

2. Redwood National and State Parks, 1111 Second Street, Crescent City, CA 95531

3. Klamath Network Inventory and Monitoring Program, 1250 Siskiyou Blvd., Ashland, Oregon

4. Mojave Network, Lake Mead National Recreation Area, 601 Nevada Way, Boulder City, Nevada

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# EXECUTIVE SUMMARY

During the period of FY2001-2004, the Klamath Network Inventory and Monitoring Program received funding to conduct a series of biological inventories, targeting vertebrates and vascular plants, as part of the National Park Service's Natural Resource Challenge. For these taxa, the core objectives of the inventory effort were to document 90 percent of the species occurring in the parks, to document abundance and distribution of species of special concern, to create baseline datasets that could be used to shape future long-term monitoring efforts, and to manage the data for quality, security, longevity, and availability (NPS, 2006).

Species were documented through data mining of existing information in the parks, voucher mining from repositories of specimens inside and outside the National Park Service, and targeted field inventories.

Data mining occurred in two phases; the first phase focused on documenting 90 percent of vertebrate and vascular plant species occurring in the parks. The protocols were developed to find and document references that contained evidence for vertebrate and vascular plant species in the parks of the Network, to contribute to species lists, and to locate information about species abundance and distribution. The second phase focused primarily on cataloging raw data for all 12 Basic Inventories and all species occurring in the parks. Voucher mining efforts consolidated information from existing records in ANCS+ and from additional vouchers located in NPS and non-NPS collections.

Targeted field inventories were carried out for the following taxa: small mammals, bats, reptiles and amphibians, fish, rare vascular plants, invasive non-native vascular plants, and birds. While the specific approach used was adjusted for each taxa, the inventories all produced datasets (that included spatial data) and summary reports. Information about species abundance and distribution was compiled and analyzed when possible. These baseline datasets are now available for use in future monitoring efforts.

Voucher mining occurred before the field inventories began; the field inventories and data mining occurred concurrently and the data mining is ongoing.

The data generated by data and voucher mining were entered into online NPS databases. Field inventory datasets, GIS files, and reports are kept and maintained by the Klamath Network office. Species lists for each park were generated by data and voucher mining and then checked against the field inventory results. The resulting species lists have been reviewed and certified by park experts and are now available for use.

This report describes the activities carried out in support of the biological inventory effort. It includes details of the methodology and the results of each activity; it describes data management practices and provides information about accessing and using the information. The Klamath Network Inventory Program was a multi-pronged, multi-year effort to document

the biodiversity of the six parks in the region. This report summarizes those efforts and places the inventories into the wider context.

The Klamath Network conducted the inventories through its own staff and several research partners including scientists from Ball State University (Indiana), Humboldt State University, Klamath Bird Observatory, Oregon State University, Southern Oregon University, Redwood Sciences Laboratory, and the U.S. Geological Survey. These cooperative efforts strengthened regional partnerships and ensured that the inventories were conducted by regional experts.

# CHAPTER ONE: HISTORY OF THE INVENTORY PROGRAM

The mission of the National Park Service is to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations (National Park Service, 1988). Park managers, who have the responsibility for making management decisions that support the mission of the Service, have a need for comprehensive, scientifically based information about the nature and condition of selected biological resources occurring within park boundaries. In the past, research was funded and conducted by outside entities or institutions; the parks were given copies of the final reports but since the projects weren't originating within the parks they didn't necessarily fill NPS research needs. Individual parks conducted research projects but the resulting data and knowledge gained stayed within the park and was subject to the vagaries of institutional memory. Many parks have considerable resources from these kinds of efforts. However, the lack of a servicewide framework meant that managers might not have access to or knowledge of available resources; parks didn't have a conduit for sharing their knowledge; and information and data were gradually lost over time.

The National Park Service initiated the Inventory and Monitoring (I&M) Program in the early 1990s to begin to address the servicewide need for scientific knowledge. The program currently includes 270 parks that contain significant natural resources, and organizes them into 32 regional networks that study long-term changes in the biological resources of the parks (National Park Service, 1992). The I&M Program identified twelve inventories required for each park, known as the "12 Basic Inventories." In FY 2000, with a base increase of $7.3 million, the National Park Service initiated the Natural Resource Challenge to accelerate the completion of the inventories. One of the 12 Basic Inventories receiving emphasis in this initiative is the need for biological inventories.

The Klamath Network (KLMN) encompasses 6 National Park Service units in northern California and southern Oregon: Crater Lake National Park, Lassen Volcanic National Park, Lava Beds National Monument, Oregon Caves National Monument, Redwood National Park, and Whiskeytown National Recreation Area. A steering committee comprised of park resource staff, the Klamath Network inventory coordinator, and a science advisor with the USGS Forest and Rangeland Ecosystem Science Center (FRESC) guided the development of the inventory program for the Klamath Network.

The Klamath Network received funding in FY2001 to conduct biological inventories as part of the Natural Resource Challenge. The total project funding provided was $731,000 over four years. To outline its goals and activities for the biological inventories, in 2001 the Network authored "A Study Plan to Inventory Vascular Plants and Vertebrates: Klamath Network, National Park Service." The plan was created with technical input from managers in all six parks of the Klamath Network. It outlined the Network's strategy for meeting the core inventory objectives, and described the proposed inventory activities for the Network. It justified the priority taxonomic groups and discussed the plan and expected methodology for each targeted group. The Klamath Network then conducted the inventories with in-network

field crews or through research partners including scientists from Oregon State University, Klamath Bird Observatory, Southern Oregon University, Humboldt State University, Ball State University (Indiana) and Redwood Sciences Laboratory.

The inventories, as well as associated data mining and voucher mining efforts, were carried out from 2001 to 2004. This report summarizes the results of those efforts and provides information about accessing and using the information from the inventories.

# CHAPTER TWO: INVENTORY OBJECTIVES

The core goals of the Inventory Program, as established by the National I&M Program, are:

- To document through existing, verifiable data and targeted field investigations the occurrence of at least 90 percent of the species of vertebrates and vascular plants currently estimated to occur in the parks.
- To describe the distribution and relative abundance of species of special concern, such as threatened and endangered species, exotics, and other species of special management interest occurring within park boundaries.
- To provide the baseline information needed to develop a general monitoring strategy and design that can be implemented by parks once inventories have been completed, tailored to specific park threats and resource issues.
- To develop a coordinated network data management effort which results in readily available biological resource information for within-park management, as well as regional resource managers, scientists, and the public.

The Klamath Network has worked to achieve these goals through data and voucher mining, and through field inventories. The Inventory Program is also designed to pave the way for long-term monitoring, by providing baseline data and by gathering the information that park staff will need to make decisions about what resources to monitor and how to monitor them over long periods of time.

## 2.1. 12 BASIC INVENTORIES

All of the National Park Service's regional networks are charged to produce the 12 Basic Inventories for each park (National Park Service, 1992). These are the core inventories that are considered essential for park managers as they make decisions about park resources. The inventories are described below. Some inventories are being produced by other agencies with expertise in that particular area, such as the soil and geological inventories. The Klamath Network Inventory Program has focused on the biological inventories of species occurrence and distribution. During the 2001-2004 time period, the Klamath Network conducted field inventories for small mammals, bats, reptiles and amphibians, fish, and birds. Separate vascular plant inventories were conducted for non-native and rare species.

**1. Natural Resource Bibliographies.** Create bibliographies of existing research to help parks identify inventory needs.

**2. Base Cartography Data**. Acquire digital cartographic products to allow park managers to prepare maps and perform spatial analyses and assessments.

**3. Species Occurrence Inventory.** Compile and verify lists of the vertebrates and vascular plants documented to occur in the parks. Conduct new field inventories to document additional species,

especially those in plant and animal groups left out of previous inventories.

**4. Species Distribution Inventory.** New field inventories will also focus on the distribution of species of concern to managers.

**5. Vegetation Maps.** Provide parks with new maps of their vegetative communities based on recent aerial photography and following a standard classification.

**6. Soil Resources Inventory.** Soils maps are being created for parks through a partnership with the Natural Resource Conservation Service. Additional products include data about physical and chemical properties of those soils and information derived from those data about potentialities and problems of use on each kind of soil

**7. Geologic Information Inventory.** Geologic maps and digital products for parks are being completed through partnerships with the U.S. Geological Survey and state geologic agencies. Also included are an on-site evaluation of park geologic maps, resources and issues and a geologic report with basic geologic information on geologic setting and history, geologic hazards, and other geologic related issues.

**8. Water Resource Inventory.** Document the locations of streams, lakes, and wetlands digitally.

**9. Water Chemistry Inventory.** Collect water quality information for all "key" water bodies found in the parks.

**10. Air Quality Inventory.** Where the National Park Service does not have its own monitoring stations, data from U.S. Environmental Protection Agency air quality monitoring stations near parks are being summarized into an air quality atlas to assess air quality conditions in parks.

**11. Air Quality-Related Values Assessment.** Basic air quality-related information including identification of visibility and other park resources that may be affected by air quality. The information will be available through a Web-based computer program.

**12. Climate Data Inventory.** Collect basic meteorological parameters such as precipitation and daily temperature.

**Figure 1. Adapted from the National I&M webpage:**
***http://www.nature.nps.gov/protectingrestoring/IM/resourceinventories.cfm***

## 2.2. JUSTIFICATION FOR BIOLOGICAL INVENTORIES

The National Park Service is charged with managing public resources based on sound scientific knowledge. As the guardian of the nation's most beloved natural places, the public supports the agency taking a strong protective stance for the conservation of biodiversity. The National Parks encompass a diverse array of potential study ecosystems across the country. These ecosystems offer the opportunity to study systems which are relatively undisturbed, functional, and stocked with their original biota, but still face the challenges of human influences, the pressures of global trends such as climate change, and the changes caused by introduced species. The biological inventories will support the National Park Service's effort to improve

its ability to manage park resources based on scientific knowledge and principles. They will add to existing knowledge of park resources, document species which have not previously been inventoried, consolidate existing and current information and data through good data management practices, and will provide baseline data for future research efforts.

The biological inventories were conducted in accordance with scientific standards. Protocols for data collection and analysis were selected so that the final reports would withstand peer review. The inventories used consistent methods to the degree possible and appropriate across parks and species, so that the data obtained could be synthesized and analyzed across broader scales. The inventories also used partnerships to obtain data in an efficient, timely, and cost-effective manner. Partnerships with agencies like the USGS and with universities such as Southern Oregon University introduced local experts to the research opportunities in the national parks and established cooperative working relationships that will foster future collaborative research.

### 2.3. EMPHASIS ON VASCULAR PLANTS AND VERTEBRATES

For the biological inventories, emphasis was placed on vascular plants and vertebrates. This arose from national direction, but was particularly relevant because parks lacked baseline data for many taxa within these broad groups. For example, most of the parks in the Network needed inventories of reptiles and amphibians. All of the parks were deficient in their mammal inventories, primarily in the documentation of small mammals. See Figure 2 for details of the status of inventories in the Klamath Network prior to FY 2001. After several scoping meetings, the Network selected several priority species groups for baseline inventories, including small mammals, bats, reptiles and amphibians, fish, birds, and vascular plants. Several groups were also designated Species of Concern, including small mammals, rare vascular plants, and bats. Management concerns with respect to the priority taxa were also identified, ranging from population declines in amphibians to the rapid invasions of exotic plant and animal species.

Although incomplete in themselves, the emphasis on vascular plants and vertebrates contributed meaningfully and practically to the preservation of park biodiversity. Many of the most visible residents of the parks are included in these taxa groups. The targeted approach adopted by the National I&M Program and the Klamath Network provided a feasible approach given limited funding and available expertise. Program funding was divided between parks and species groups, and there were trade-offs in choosing which inventories to fund. Projects were funded that completed inventories for taxa that lacked inventories in a majority of the Network parks. Efficiency was crucial; an effort was made to identify species groups that were cost effective to inventory. Priority was also given to species that did not have other funding sources that could be used to sponsor an inventory. An effort was made to document new species and populations, and to avoid duplicative work on species that had already been documented. Included in the inventories were targeted abundance and distribution surveys for species of concern. These data will serve as important baseline information for future long-term monitoring efforts.

Priority 1: Amphibians and Reptiles. Amphibian declines have been documented throughout western North America and are of management concern in most parks. Most of the parks in the Network are significantly deficient in their Level I aquatic and terrestrial herptile inventories.

Priority 2: Mammals (Small Mammals). All parks across the Network are deficient in their mammal inventories. Although some Network parks lack species specific inventory information on certain sensitive mammal species, most Network mammal inventories are primarily deficient in documenting small mammals. Inventories of small mammals are a cost effective means to simultaneously validate each park's level I mammal inventory and to assess for species richness.

Priority 3: Mammals (bats). Bats as a sub-taxonomic group are poorly documented in all but one (i.e., LABE) of the Network parks and are anticipated as a future management concern due to their specialized habitat requirements.

Priority 4: Fish (freshwater). Only one Network park is deficient in their Level I inventory for freshwater fish. Fisheries management is a current and future concern at this park.

Priority 5: Vascular Terrestrial Plants (Threatened, Endangered and Sensitive Species). All parks in the Network are believed to currently meet the Level I inventory threshold for vascular plants. However, most parks have specific data gaps for specific sub-taxa. None of the parks have a comprehensive sensitive plant inventory.

Priority 6: Vascular Aquatic Plants. Aquatic plants are poorly documented in most parks across the Network. These plants are normally associated with sensitive habitats and are an important management concern.

Priority 7: Vascular Terrestrial Plants (Exotic species). All parks in the Network have significant concerns with exotic vascular plants that are currently threatening or impacting native ecosystems. Although presence/absence is generally known, new invasions may be undocumented. Determining distribution and abundance of highly invasive exotic species is an important prerequisite to develop effective control and monitoring strategies.

Priority 8: Birds (Neotropical migrants). All Network parks either meet or approach their Level I inventory for birds in general. We expect that the Level I threshold will be met in most units by future data mining or by continued interagency and private sponsorship efforts. Documentation of neotropical migrants, however, are of particular management concern due to threats across their range.

**Figure 2. Klamath Network Priorities (from Acker et al., 2001)**

## 2.4. DATA MANAGEMENT SYSTEM

A comprehensive data management system is an integral part of the I&M Program. The data management for the data mining and field inventory effort must maintain the quality of the data through quality check procedures, must keep data secure physically and electronically, must preserve data by maintaining it in an up-to-date format with sufficient documentation, and must make data available to those who would use it.

## A. Data Mining

The data management for data mining efforts required extensive data entry and quality checks. The tools developed by the NPS to handle the entry of data from disparate historical and current sources include three different databases. The databases are (or will be) linked to each other and are available online. They are also available in desktop formats for park users who do not have access to a high-speed internet connection. A short description of each database follows.

> **NatureBib:** An internet-based bibliography of natural resource references concerning NPS Units. NatureBib is developed to fulfill the "bibliography" component of the 12 Basic Inventories. It is designed to facilitate communication among researchers and make natural resource information more readily available and easy to locate. Some of the key components of the database include: title, author, date, abstract, and holdings location. The database is linked to NPSpecies and is available in both online and desktop interfaces.
>
> **NPSpecies:** A database to store, manage and disseminate scientific information on the biodiversity of all organisms in NPS units. It is linked to NatureBib, and is available in both online and desktop interfaces. Three types of species evidence are entered into NPSpecies: references, vouchers, and observations.
>
> **Dataset Catalog:** A desktop tool for keeping an inventory of datasets, with abbreviated metadata, about a variety of natural resource datasets. Data and documents can be linked to NatureBib. The input and report forms provide a straightforward way to document all types of resource datasets that may or may not have met formal metadata standards. Dataset catalog records can be uploaded to and accessed through the NR-GIS Data Store.

The data miners used versioning (of file names and directory names) to keep track of changes in data files. Entered data was verified by quality checking the entered data against the hard copy. The Data Manager addressed misspelled species names and duplicate species names as part of the validation process.

## B. Field Inventories

The National Park Service Project Inventory, Tracking, and Reporting Database was developed by the Upper Columbia Basin Network to track the status of I&M projects and has been modified for use by the Klamath Network. All field inventory projects are entered and updated in this database. The database tracks overall project schedule and budget, Principal Investigator contact information, and reporting deadlines. It catalogs submitted products, and also gives synopses of project objectives and activities. The database is stored on the network drive at the Klamath Network office.

Each field inventory Principal Investigator (PI) was given a copy of the Klamath Network requirements for inventory project deliverables. That form is attached to this report as

Appendix A. The Network asked that each project submit: 1) a complete, clean set of field forms; 2) digitized (in Access or Excel) and verified/validated datasets; 3) all related images in JPEG format with appropriate file names and metadata to explain them; 4) copies of protocols and other field forms used; and 5) fully metadata compliant GIS/GPS files in NAD 83 datum.

The materials associated with each field inventory were generally delivered to the Network in electronic format. Many of these files have been printed and are stored in paper copy also. The locations of all project paper and electronic files are stored in the tracking database. In general, the products of the field inventories included datasets, images, GIS files, and reports. The files are kept in the Inventories folder on the network drive, and the file structure breaks the files into several groups: Work Statements and Proposals, Data, Field Documents, Images, GIS, Reports, and Supporting Documents. Some of the projects also have metadata (stored in the Data folder); metadata still needs to be generated for other inventories. Inventories should also have their contract or task agreement paperwork filed with the project in the subfolder Work Statements and Proposals. Some projects (bats, invasive non-native vascular plants, rare plants, and one year of birds) have had GIS layers generated already, while others simply supplied shape files or UTMs. For these projects, the datasets should be transferred into a GIS usable form by pulling out species presence and relative abundance and referencing it spatially. The datasets are in varying formats (spreadsheets, databases, and text files) and this will take varying amounts of time for each.

**C. Klamath Network GIS Resources**

In FY04, the Network provided funding (mostly monitoring funds) through a Task Agreement to Southern Oregon University to hire a GIS Specialist and to provide access to the geographic information laboratory at Southern Oregon University. The GIS Specialist has worked to expand the GIS resources of the Network, including inventory resources. He conducted spatial analyses and created GIS layers for some of the field inventories, including the non-native vascular plant inventories and the bat inventories.

The specialist has also worked with park staff and others to compile, edit, and analyze data layers from the parks and the states of California and Oregon. In FY05, copies of park level GIS databases were collected from the parks. The layers applicable to I&M were selected and transferred into an organized structure on the Network GIS Drive. About 75 percent of the existing park layers were considered applicable to I&M. The layers were adjusted to use a consistent projection (UTM 83) and naming conventions across all the parks. This regional Network dataset is a resource for researchers and park staff conducting research in the Network parks.

Layers from outside sources that are applicable to the biological inventories, such as plant and animal distribution maps, are also being collected. So far, distribution maps for trees, birds, and mammals have been acquired from NatureServe and elsewhere.

# CHAPTER THREE: KLAMATH NETWORK INVENTORY APPROACH

The inventory efforts of the Klamath Network consisted of data and voucher mining by National I&M and Klamath Network staff, and also targeted field inventories conducted within the Network or through cooperative partnerships with outside institutions. The following sections discuss each set of activities in detail, and include information for accessing data and reports.

## 3.1. MINING

Network voucher mining activities occurred in 2001-2002, and were conducted by the Klamath Network Data Manager. Data mining began in 2004 and is ongoing, conducted by the Data Mining Team of the Klamath Network.

### A. Data Mining

The Klamath Network Data Mining Team (DMT) locates and documents existing information about the natural resources of the six parks of the Klamath Network. All of the parks have collections of information about their resources, in various formats and stages of organization. Formats include: reports (formal and informal), technical reports (public and private), management plans, theses/dissertations, books, popular and peer-reviewed journals, research permits, field notes, letters, maps, photographs/images, and datasets. The data mining effort targets the natural resource and species information contained in these references and documents it in nation-wide online databases (NPSpecies and NatureBib), in a consistent, accessible format, designed to support future management decisions.

The data mining project has occurred in two phases.

The first phase of data mining focused on the biological inventory goal of documenting 90 percent of vertebrate and vascular plant species occurring in the parks (Truitt and Smith, 2005). Phase I data mining methods were developed to find and document references that contained evidence for vertebrate and vascular plant species in the parks of the Network, to create comprehensive species lists, and to locate information about species abundance and distribution.

The second phase has focused primarily on cataloging raw data for all 12 Basic Inventories and all species occurring in the parks (Bridy, Perry, and Shepherd, 2006; Bridy, Perry, Shepherd and Truitt 2005). Because this phase began after FY04, and is currently ongoing it is generally beyond the scope of this report. However, summary information is available below in the Phase II section.

Phase I began January 2004 and concluded September 2004 for all of five units in the Klamath Network, and part of a sixth unit. Because the sixth unit, Redwood National and State Parks,

contained a vast amount of references, Phase I continued at this park with changing team members from September 2004 to March 2005 and June 2005 through December 2005. During Phase I, the DMT entered bibliographic and species data for the six priority biological inventories (amphibians, birds, reptiles, fish, mammals, and vascular plants).

*Methods:*

A summary of the protocols for Phase I data mining follow. For each Klamath Network park unit, if a reference contained information about any of the six taxonomic groups, and was not already in the NatureBib database, it was entered into NatureBib. If a reference also contained scientific species names associated with a Klamath Network park unit, then those names and references were linked in the NPSpecies database. References containing only common species names were only entered into NatureBib (except standardized bird common names at Redwood, at the request of the Supervisory Wildlife Ecologist). At most parks, the NatureBib number was written in pencil on the document or on a post-it note that was placed on the document.

*Accomplishments:*

The DMT added a substantial amount of reference information for biological inventories into NPSpecies and NatureBib. They also added new species to the NPSpecies lists for each park. See Table 1. For example, at Redwood, over 400 new references, which contained mention of over 1450 species, were entered into NatureBib and linked to NPSpecies. For at least two parks, the number of references in NPSpecies approximately represents the amount of work done: Lava Beds had no references in NPSpecies before data mining, and Whiskeytown only had 1 reference to begin with.

**Table 1. Number of references added to NatureBib and NPSpecies for each park during FY04 data mining**

| Park | NPSpecies references | NatureBib references |
|---|---|---|
| CRLA | >231 | 406 |
| LABE | 209 | 444 |
| LAVO | 70 | 404 |
| ORCA | 51 | 529 |
| REDW | 404 | 720 |
| WHIS | 102 | 191 |

*Resources Available and Accessibility:*

By conducting Phase I of data mining, the vascular plant and vertebrate references contained at Klamath Network parks are now searchable and locatable via the internet. NatureBib and NPSpecies are available to NPS staff and resource managers through any internet connection, inside or outside the NPS, via a login. The login can be obtained through the Klamath Network Data Manager. Both NPSpecies and NatureBib will be available to the general public without a login in the near future, although sensitive information will be restricted. NPS staff and resource managers can now view a list of the resources available for a given species and park in a standardized online format that can be accessed remotely. The DMT entered the locations of

physical references at the parks in NatureBib and labeled most of those documents with the NatureBib BibKeyID number so that references would be easy to search and locate.

In addition, data mining "rediscovered" research that was lost or forgotten, and made it searchable and accessible. For instance, data miners at Lava Beds rediscovered a map describing the results of a 1936 vegetation survey by Roseberry and Mitchell. Also rediscovered was a 1938 vegetation survey report by Applegate that had never been entered in NPSpecies.

The main organization of the NPSpecies database allows searching for a species by park, and generates lists of species by park, as well as lists of parks in which a particular species occurs. It is possible to look up a species and see a list of the vouchers available (see the Vouchers section), references that the park has about that species, or a link to NatureBib to look up more information about the references (such as holdings location). Other fields of information in NPSpecies are listed in Table 2. The Klamath Network data mining effort focused on entering and linking scientific species names and associated evidence references. Species attributes were filled in during the certification process. It is important to remember that not all of these fields have been populated and that an empty field does not mean that a park has no information about it. Data entry into NPSpecies is an ongoing process.

**Table 2. Species-related data fields in the NPSpecies database**

| Checklist Fields | Management Fields | Evidence Fields |
|---|---|---|
| Park Status | Weedy Plants | Vouchers |
| Abundance | Pest Organisms | Observations |
| Residency | Management Priorities | References |
| Nativity | Exploitation Concerns | Data Sets |
| Cultivation | | NatureBib/Biodiversity Data Store |

*Phase II: The Present and Future of Klamath Network Data Mining*

The second phase of data mining began at Redwood in fall 2005 and is currently ongoing within the Network parks. Its primary focus is on cataloging raw data for all 12 Basic Inventories and all species occurring in the parks. The first part of Phase II has involved training data miners to use several new databases, including Dataset Catalog and the NPS Metadata Tools. The DMT members are entering data into these databases and uploading this information, as appropriate, into the NR-GIS Data Store. The secondary focus is on expanding the information entered into NatureBib and/or NPSpecies to include invertebrates, non-vascular plants, digital formats and the remaining 12 Basic Inventories (e.g. soils, geology, weather, and air).

The general methodology of Phase II is to query resource managers at each park for the scope, location, and priority of park datasets. Descriptive information about datasets is entered into Dataset Catalog and/or the NPS Metadata Tools, such as dates the data was collected, originator, summary, methodology, sensitivity, and location. This information can be uploaded to the NR-GIS Data Store as deemed appropriate by the Klamath Network Data Manager and

the researchers. The secondary priority is entering information into NPSpecies and NatureBib using similar methodology as Phase I.

The accomplishments of Phase II as of April 2006 include the development of protocols, ongoing mapping, description and mining of digital data on network drives at Redwood, completion of 20 metadata interviews, and 16 Dataset Catalog records. Data miners are currently working with National Database Developers to create protocols for the uploading of Dataset Catalog records into the NR-GIS Data Store. Since the end of fiscal year 2004 to April 2006 at Redwood, 3,662 references have been added to NatureBib, bringing the total to 5,594. Also, the Redwood component of NPSpecies has been expanded by 1,326 references and 3,092 species, bringing the total to 1,756 references and 6,533 species.

Park staff can use the internet to access the NR-GIS Data Store. This database can be used to search and locate research data. The results vary depending on the standard used to create the records and the availability of current information about the data. Searches can be done by record type, NPS unit, category, subject, keyword, title, or abstract. Dataset Catalog records that are available locally can be searched by similar and additional information.

*Reports:*

Bridy, L, B. Perry, T. Shepherd. 2006. Redwood National and State Parks Data Mining Summary. 7 pp.

Bridy, L., E. Perry, T. Shepherd, and R. Truitt. 2005. Klamath Network Data Mining Phase II Protocols. 16 pp.

Bridy, L., R. Miller, C. Powell, B. Shaw, S. Smith, and H. Waterstrat. 2004. Klamath Network Data Mining Final Report for FY 2004. Klamath Inventory and Monitoring Network, National Park Service. 55 pp.

Truitt, B. and S. B. Smith.. 2005. Klamath Network Data Mining Protocol: KBaM! Klamath Inventory and Monitoring Network, National Park Service. 22 pp.

**B. Voucher Mining**

Vouchers in parks, universities, and other institutions represent an important source of data relating to species and their distribution. Vouchers are physical evidence of species existence, such as specimens (complete or partial), audio recordings, or images. When they are connected with locations and dates, they can provide fundamental proof of the historical range of a species. By understanding the historical status of species, park staff and scientists can begin to identify the changes that have occurred and to investigate the causal mechanisms of change. Vouchers also support the goal to document 90 percent of the vascular plants and vertebrates within the national parks.

Voucher mining activities for the parks in the Klamath Network were split between centralized efforts by the Central Office in Fort Collins, Colorado, and efforts by the Data Manager in the Klamath Network office. The Central Office imported pre-existing records from ANCS+ into

NPSpecies and searched non-NPS collections on the national level. Between the spring of 2001 and spring of 2002, the Klamath Network Data Manager searched for park vouchers by submitting queries to park staff (including both NPS curators in the Network) and regional experts familiar with the targeted taxa. Non-NPS collections were also sought out and searched, including museums and universities with digitized catalogs that could be searched online or requested.

The Data Manager searched non-NPS herbaria, herpetology, ichthyology, and ornithology collections. If a collection was available online it was downloaded; otherwise, contact was made by phone or email and digitized records were requested if they were available. Over thirty outside sources were contacted. The records were searched for both vouchers that had location information that placed them in the parks and vouchers with ambiguous locational information that could have come from park areas. Vouchers with uncertain locations were put into list form that could be searched easily, and park staff were asked to inspect the lists for locations they recognized. The final list of vouchers was imported into the NPSpecies database, and each park received a copy of the complete final list. The Network also obtained the recent versions of park ANCS+ files and submitted them for upload to WASO.

The Center for North American Herpetology
Bats Northwest
Biota of North America Program
Breeding Bird Survey Summary and Analysis, version 98.1
Burke Museum, Herpetology
CalFlora
California Academy of Sciences
California Department of Fish and Game, California Natural Diversity Database
Cornell University Museum of Vertebrates
Humboldt State University Natural History Museum
Humboldt State University Department of Wildlife
Humboldt State University Fish Database
Humboldt State University Herbarium
Oregon Heritage Program
Oregon State University Deptartment of Zoology
Oregon State University Herbarium Databases
Oregon State University Insect Collection Holdings
Smithsonian National Museum of Natural History
Southern Oregon University Department of Biology
The EMBL Reptile Database
The Nature Conservancy
U.S. Natural Heritage Programs
UC Berkeley
UC Davis Museum of Wildlife & Fisheries Biology
UC Davis Herbarium
University of Kansas Natural History Museum
University of Michigan Museum of Zoology
University of Minnesota
University of Missouri
University of Oregon Museum of Natural History
University of Washington Fish Collection
University of Washington Herbarium

**Figure 3. Institutions "Mined" for Vouchers**

The mammal, amphibian, and reptile groups produced many new vouchers. The fish group was greatly enhanced by voucher mining. There were fewer vouchers available for birds. The vouchers that were found for vascular plants came from local and regional herbaria such as university herbaria in Oregon and California, though it is believed that older collections at national herbaria would also be good potential sources.

Many of the challenges of voucher mining came from working with historical records. Collections that were not digitized could not be searched efficiently. The work required a close enough familiarity with each park to recognize localized place names, and not just current names but historical names for landmarks now within park boundaries. Some vouchers gave

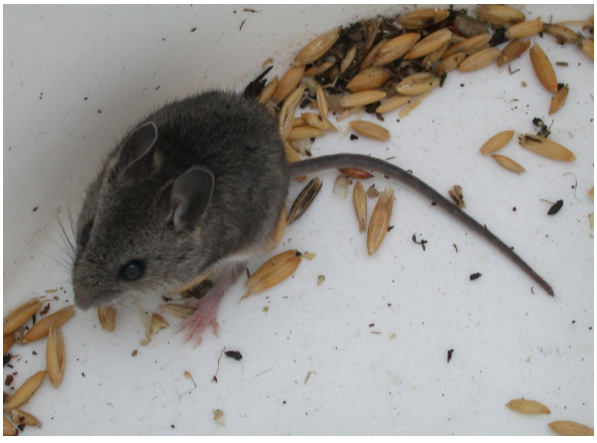
such generalized location names that it was impossible to tell whether the voucher came from within park boundaries. It also required the time and patience to search for collections both in the immediate region and beyond, to locate the person responsible for the collection, to contact more than one person if the collection was divided into the different disciplines (ornithology, herpetology, etc.), and then to filter though all the information received from these contacts.

The voucher mining produced over 3500 new vouchers for the parks in the Klamath Network, including 400 new species. It resulted in a large and usable dataset of historical species information. The effort led to the rediscovery of resources in the parks (such as bison remains at Lava Beds, a lynx skeleton at Whiskeytown, and an extirpated salmon species at Oregon Caves) and of resources outside the parks. For example, a large, digitized dataset of species observations was located and obtained from the Oregon Heritage Program. In addition, inquiries to Cal Academy for voucher data also produced information about species observations and other available references. This information resulted in the creation of additional evidence records for the parks, containing the voucher's location, the voucher type, and sensitivity information. Most importantly, through the use of NPSpecies, the voucher mining put this information into a consistent, user-friendly format accessible to park staff. Users should also remember that not all existing vouchers may have been entered into NPSpecies yet.

### 3.2. FIELD INVENTORIES

The following sections cover the details of the field inventories conducted by the Klamath Network, including the timing of the projects, the parks and researchers involved, and general information about the protocols, results, and the products delivered to the Klamath Network. For more information on any of these inventory projects, please refer to the reports cited for each project.

#### A. Small Mammals



***Peromyscus truei* in a pitfall trap.**

Small mammals were the second highest priority for inventory efforts. They ranked highly because small mammals make up the majority of mammal diversity in the Klamath Parks and because they are believed to be undersampled due to their secretive or nocturnal habit and low levels of previous study. The inventory was conducted during the 2002 and 2003 field seasons by Scott Mahady, Klamath Network Wildlife Biologist. Five of the parks were sampled in 2002 and the final park, Whiskeytown, was sampled in a more intensive, single-park effort in 2003. A toolbox approach of live trapping with Sherman traps and pitfall trapping was employed, and transects were placed in a variety of habitats. Three transects were trapped in Lava Beds, Redwood, and Crater Lake; two transects were trapped at Lassen

Volcanic, and six transects were trapped at Oregon Caves. At Whiskeytown, nine transect sites were selected randomly from a pool of sites that encompassed the full range of habitats and elevation zones present in the park.

The goals of the small mammal inventory were to document the occurrence of 90 percent of the small mammal species currently estimated to occur in each park and to provide baseline data anticipating a possible long-term monitoring program. While the inventory did not reach the 90 percent mark, it did document previously unconfirmed species for four of the six parks. Voucher specimens were collected for six species. The effort at Whiskeytown confirmed the presence of three additional species, increasing that park's level of documented species occurrences to 77 percent. The project detected and documented a total of 30 small mammal species, and produced datasets that included summaries of species presence, relative abundance, selected environmental data, and spatial (UTM) coordinates for the transects. Collectively, the two annual reports provide tables of relative abundance for non-flying and non-arboreal small mammal species sampled across the six Klamath Network parks. It is important to keep in mind that these numbers are rough estimates. Captured individuals were not marked, and it is impossible to know how many individuals were captured more than once. It is assumed that some individuals and species were attracted to the bait in the traps while others shied away from them. While the methodology used does not allow precision, the ranked relative abundances of species generally show the expected negative exponential (concave) pattern yielded by most biodiversity inventories (See Figure 4). One of the main benefits of the inventory was the documentation of the presence of many moderate- and low-abundance species. The effort also identified a research need for the Townsendii complex of chipmunks, and provided several park-specific recommendations for updating taxonomic names or improving park species lists.

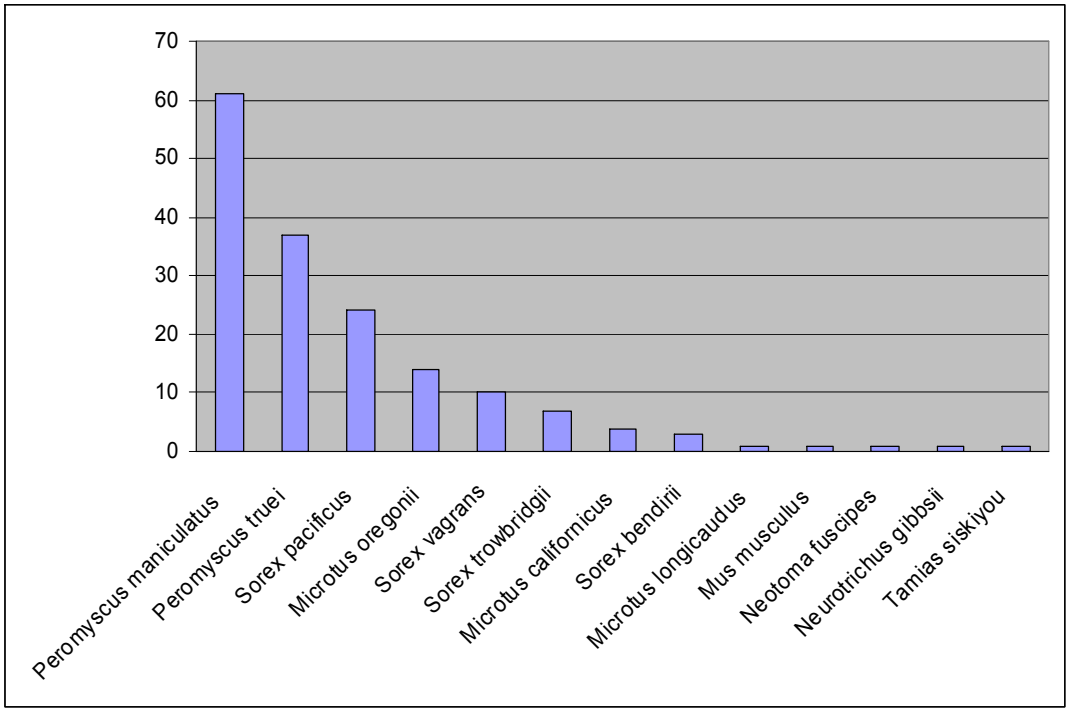



**Figure 4. Small mammal estimated relative abundances at Redwood.**

*Small Mammal Inventory Reports:*

Mahady, S. 2002. Annual Report for the Klamath Network Inventory Program: 2002 Small Mammals Inventory. 6 pp.

Mahady, S., and W. Bunn. 2004. Annual Report for the Klamath Network Inventory Program: 2003 Small Mammals Inventory. 4 pp.

**B. Small Mammals (Bats)**

The rationale for carrying out a separate small mammal inventory for bats was laid out in the Klamath Network Study Plan (Verts and Carraway 1998):

> As secretive, mobile, and nocturnal animals, bats are often under represented in native wildlife inventories. The life histories of many species of bats are poorly understood, yet their longevity, low reproductive rates, and strong habitat preferences suggest they may be potential indicator species in landscapes. Regional and continent-wide declines in bat populations have heightened attention for these species.

The bat inventory effort, led by Dr. Tom Morrell of Ball State University and carried out by Andrew Duff, made a substantial contribution to knowledge about the bat populations in the parks of the Klamath Network. Bat surveys were conducted during the summers of 2001-2005 in all the parks. The objectives of the study were to determine the diversity and relative abundance of bats in each park, determine species distributions, produce predictive species occurrence models based on landscape-scale parameters, and compare acoustical and live capture techniques for documenting species occurrence. During the 2001-2003 field seasons, mist netting was conducted at Whiskeytown, Lassen Volcanic, and Lava Beds. During the 2004-2005 field seasons, data collection was conducted at Crater Lake, Oregon Caves, and Redwood using mist netting, harp traps, and Anabat II acoustical detectors. Concurrently deploying acoustical and live capture techniques allowed researchers to compare the methods for inventorying bats. At Oregon Caves, the research team was primarily tasked with determining the effect of bat friendly gates on bat activity in cave entrances.

These efforts contributed significantly to the existing knowledge of bat populations in the parks of the Klamath Network. See Table 3 for the number of sites sampled with mist nets in each park and the number of species that were positively identified. No new species were added to Network lists, but the presence of fourteen species across the parks was confirmed during this effort. This project provided the parks with reliable, current species information, and gave valuable perspective on existing lists of species.

**Table 3. Number of Species Detections by Park**

| Park | Sites Sampled | Species Identified |
|---|---|---|
| WHIS | 47 | 10 |
| LAVO | 33 | 8 |
| CRLA | 20 | 9 |

| | | |
|---|---|---|
| ORCA | 2 | 4 |
| REDW | 22 | 12 |
| LABE | 3 | 9 |

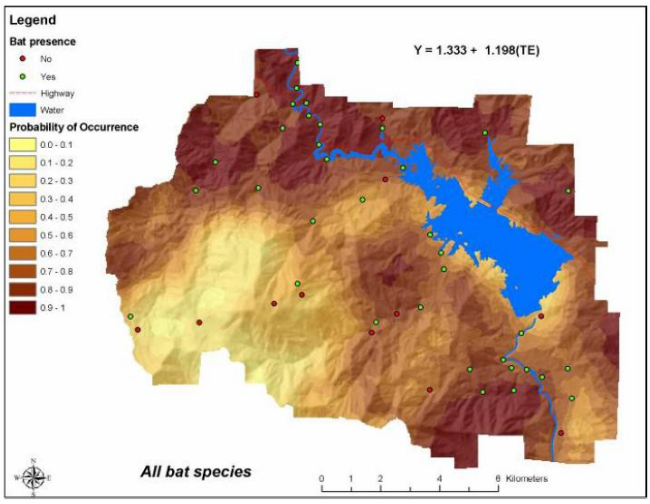



**Figure 5. Example of species occurence map for WHIS**

The products of the inventory include, for each park: baseline tabular datasets with spatial data, GIS-based predictive occurrence maps for Whiskeytown and Lassen Volcanic, measures of species diversity and relative abundance for all survey sites, and recommendations for long-term monitoring. The Klamath Network has copies of these products in the form of datasets, end of season and final reports, and maps.

The preliminary investigation into bat friendly gates at Oregon Caves found that gating would not significantly affect bat activity. The wide range in sample sites across parks in elevations and habitats allowed for population trends across the Klamath Network to be observed, including higher species richness at lower elevations, higher bat abundance in drier climates, and changes in the male to female ratio across the parks.

In addition, the research team found that when mist netting and acoustical sampling techniques were used concurrently, the number of species detected increased; having an acoustical measure of bat activity helped with decisions about when to close the mist nets; and the two methods complemented each other when species distinctions were not clear. The recommendations the researchers made for long-term monitoring included surveying at permanent sites at an interval of at least two to five years; conducting simultaneous mist netting and acoustic sampling; and surveying sites at least four times a survey season and more than a week apart each time. They also recommended that sampling should be conducted to include the full range of habitats and elevational ranges in each park.

*Reports:*

Duff, A. 2004. Klamath Network Inventory and Monitoring Program: 2004 End of Season Report for Bat Inventories. 9 pp.

Duff, A. 2005. Klamath Network Inventory and Monitoring Program: 2005 End of Season Report for Bat Inventories.

Duff, A. 2005. Distribution, Relative Abundance, and Activity of Bat Species in CRLA, ORCA, and REDW Including a Comparison of Live Capture and Acoustical Techniques for Documenting Species Occurrence. 54 pp.

Morrell, T. E. and A.A. Duff. 2005. Distribution and relative abundance of bats in Whiskeytown National Recreation Area, Lassen Volcanic National Park, and Lassen National Forest: with emphasis on predicting bat occurrence using landscape scale characteristics: Final Report. 136 pp.

**C. Vascular Plants**

Separate inventories were conducted for rare and non-native plant species. A cursory inventory of aquatic plant species was also done at Whiskeytown.

*Rare*

The rare vascular plant inventory effort focused on finding new rare species and new populations of rare species known to occur in the parks. The parks are all believed to be over the 90 percent threshold for documented vascular plants, but rare species are a priority in the biological inventories, and vascular plant lists often include a higher percentage of rare species than other taxa. Many of the parks have rare species on their existing lists, but the potential for additional unknown species exists, due to undersampling of specific habitats (like aquatic habitats) and taxa that are challenging to identify (like sedges). This effort sought to identify and document additional species by addressing suspected gaps in existing lists, and to augment existing information on the distribution, abundance, and habitat characteristics of rare species. Aquatic species were identified as a group of interest because aquatic habitats have been undersampled in the past.

The rare plant inventory effort used information generated by voucher mining and data mining. A list of rare species either known or suspected to occur was generated for each park through a review of existing park information and online databases maintained by groups like the California Native Plant Society. Park botanists also helped compile lists of species that were expected to be found, but had not been documented, in the parks. The selection of target species and locations to survey was done with guidance from park staff.

Three approaches were used: targeted surveys in distinctive local habitats suspected to harbor unusual species, revisits of historic populations using the targeted survey methodology, and quantitative belt surveys in habitats too large to allow a thorough survey. In the methodology used, when the crew encountered a suspected rare species they took a voucher specimen (under controlled circumstances), took GPS points and digital images, and recorded site data using standardized Klamath Network forms.

The field surveys occurred during the spring and summer of 2003. The project PI was Dr. Erik Jules of Humboldt State University. At Whiskeytown, park staff asked the crew to focus on revisiting known sites of rare plant populations. Four of the populations were relocated, but several were not, including a population of *Penstemon purpusii* on Shasta Bally. At Lava Beds,

the vascular plant list contained one rare species; a list of other potentially occurring species was also generated. Transects were surveyed in the major habitat types of the park, and three targeted surveys were also conducted, but no new or rare taxa were found. It was recommended that future efforts examine the less accessible areas of the monument, including cave collapses and lava flows. At Redwood, park staff asked the crew to focus on two areas, the Little Bald Hills and the Tracy Property. Several rare species were detected at both sites, including two species previously unknown to the park. The searches were limited by time, and further efforts using the targeted search method are recommended. At Oregon Caves, targeted surveys were conducted in riparian and rocky outcrop habitats, and two new species were found. At Lassen Volcanic, three new species were found in targeted surveys of wetland and aquatic habitats. At Crater Lake, several rare species were located in known and new areas.


***Drosera x obovata*, newly dectected at CRLA**

The inventory generated tabular datasets of all species encounters, including species, environmental, and spatial data. A final report, with recommendations for future rare plant inventory efforts, was generated, and datasets and photos were submitted to the Network. Voucher specimens were submitted to the respective parks. While the effort was too small to allow for effective analysis of species abundance and distribution at the whole park scale, the resulting datasets provide baseline data for future efforts. The inventory of the Little Bald Hills, an area of serpentine soils and a center of rare plant species in Redwood, provided a useful summary of the relative abundances of several regionally rare species at the site.

The overall survey effort was relatively modest, in terms of the amount of time the crew was able to spend at each park, but new species and new populations of known rare species were located at several parks. The success of the surveys was limited by the phenological timing of the surveys and local climatic conditions; additional rare plant survey efforts at different times of year and under different conditions would likely find additional unknown species and populations.

A separate, informal survey of aquatic species was conducted at Whiskeytown by Network staff in 2003. A report summarizing the result of the inventory will be produced and submitted.

*Reports:*

Smith, S., J. Filipski, B. Basor, D. Sarr, and E.S. Jules. 2003. Annual Report for the Klamath Network Inventory & Monitoring Program: FY 2003 Rare Plant Inventory. 20 pp.

*Invasive (Non-native)*

The Klamath Network Inventory Study Plan gave four objectives for non-native plant species: the development of complete checklists of non-native plant species in disturbed locations in each park, the establishment of baseline information for future monitoring of exotic plant distribution and abundance, the development of ecological threat assessments for non-native species, and a checklist of threat characteristics for each park based on field data, literature review, and local park knowledge. The ecological threat assessments are being funded under the USGS Early Detection Monitoring Project, but the other two objectives were addressed as part of the biological inventory effort.

A comprehensive inventory of all non-native species occurring in the six parks would exceed available funding. Therefore, the initial effort concentrated on habitats within the parks that were the most likely locations for non-native invasions. This included riparian and wetland areas, areas of past or ongoing human disturbance (roads, trails, developed areas, campgrounds, and livestock areas), and areas disturbed by fire suppression and wildfires. The parks were asked to guide the choice of study sites based on their priorities and knowledge of the gaps in their pre-existing data. The parks already actively manage invasive species, and involving them in the project design ensured that the project used the available funding efficiently and did not duplicate park efforts.

The inventories were done in five of six parks during the spring and summer of 2003 (park staff at Redwood wanted the field work done in their park to emphasize rare plant surveys). The study was conducted by Klamath Network staff and field crews. The methodology measured for species presence, abundance, and distribution. It sought to measure the influence of biophysical factors (elevation, overstory, slope, and disturbance level) and distance from road in species presence and abundance. Three survey methods were utilized: site profile surveys of known disturbed areas, targeted mapping of invasive species, and quantitative belt plots along roads and trails. The study sites were located to include a variety of elevations and disturbances. Presence/absence data was recorded, documenting sites where non-native species did not occur as well as sites where they did. This is in contrast to past park efforts that were geared towards eradication and did not include absence data.

Site profile surveys captured presence and abundance (based on estimated cover) of non-native species at sites known to have high levels of human disturbance. Sites were chosen that were affected by visitor use and park management, or by historic impacts such as historic home sites, mining, and logging.

Targeted species mapping was based on locating and mapping new populations of non-native species or mapping particular noxious species in sensitive habitats. It involved hiking reconnaissance along park boundaries and riparian zones, and also involved some roadside surveys.

Quantitative belt plots were installed on randomly selected road and trail segments at different elevations and vegetation strata in each park. Large (4 hectare) macroplots were established to sample a representative range of species. The macroplots each had four 400 x 25m quantitative

belts parallel to a straight section of road or trail, to measure the effect of distance from the road. The plots were searched for non-native species for 45 minutes, and biophysical data such as canopy cover, slope, and evidence of disturbance were recorded.

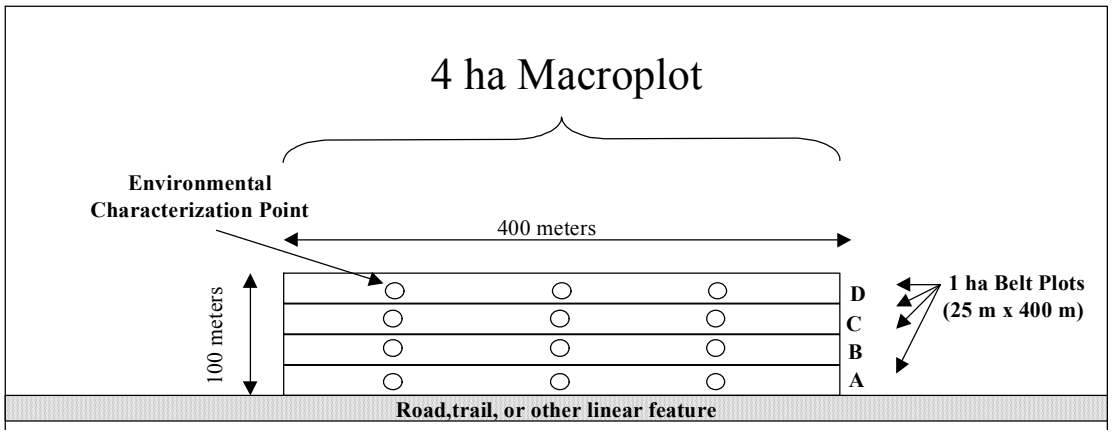



**Figure 6. Aerial view of the four (1 ha) quantitative belts used in non-native plant sampling.**

Quantitative belt plots A-D are arrayed parallel to a road or trail at increasing distances into the native vegetation. Each quantitative belt is 400 m long and 25 m wide and comprises one hectare, for a total of 4 hectares per aggregate sample. Environmental sampling points are shown.

Whiskeytown used all three methods. Site profile surveys were completed for the most highly impacted areas of the park. Targeted species mapping was done for seven stream corridors infested with Himalayan blackberry (*Rubus discolor*). Quantitative belt plots were installed at sites that spanned much of the elevation range of the park. At Lava Beds, belt plots were installed at sites along roads and also trails, and augmented park efforts to map non-native species. In Oregon Caves, two belt plots were installed along trails. At Lassen Volcanic, targeted species mapping was done along the south boundary of the park, and in the southwestern corner of the park. Belt plots were installed along roads and trails. At Crater Lake, targeted species mapping occurred at several wetland areas and trails, and site profile surveys were done in two developed areas of the park. Driving inventories were also conducted using park's non-native plant road inventory protocol.

The data analysis of the belt plots found that the elevation of the plot and overstory cover were both significantly associated with the species richness of non-native plant species. All of the belt plots were located next to a road or trail and vulnerable to seed introduction; the presence of an established infestation appeared to be explained by elevation and light availability. Lower elevation plots with an open overstory showed higher non-native species richness than higher elevation plots or plots with a closed overstory. As an example, at Whiskeytown, the lower elevation belt plots contained 5 to 38 non-native plant species, the mid elevation plots contained 4 to 8 species, and the high elevation plots contained 0 to 4 species. During the site profile surveys at Whiskeytown, 68 different non-native plant species were identified, with between 25 and 44 species found at each site, but at Crater Lake, only 8 species were encountered and the highest number of species at any one site was 7.

Light availability also played a role in species richness. The belt plots captured the gradient from disturbed roadsides to undisturbed native vegetation. At Lava Beds, which has a uniform, open overstory, there was little difference in species richness between the four belts in each plot. At Crater Lake, which is heavily forested, non-native species were only found within three meters of the roadside during the site surveys.

Species abundance maps were prepared for eight non-native species at Whiskeytown, and for three species at Lava Beds. Reports, images, and tabular datasets with spatial and environmental data are on file at the Klamath Network office.

This effort was a small but focused, well-designed study that used statistically defensible methods to investigate the factors leading to successful establishment of non-native species. The data collected will be used as baseline data for future monitoring efforts and will contribute to the future development of more extensive park-wide distribution maps for invasive non-native species.

*Reports:*

Sarr, Daniel, A. Shulfelberger, M. Commons, and W. Bunn. 2003. Annual Report for the Klamath Network Inventory Program: FY 2003 Non-Native Plant Inventory. 36 pp.

**D. Herpetofauna (Amphibian and Reptile) Inventory**

***Ensatina* spp. at Whiskeytown NRA**

The Inventory Study Plan designated amphibians as the number one priority in the Klamath Network, because five of the six parks did not have a comprehensive survey for reptiles and amphibians and lacked distribution and abundance information. The park that did have good prior information was Redwood. The primary objective of the inventories was to completely document the herpetofauna of each park. The plan was to conduct habitat and species-specific surveys for suspected taxa in parks that already had some species information, and to implement more widespread surveys in the less-studied parks such as Whiskeytown and Lava Beds. The second objective of the inventories was to develop distribution and abundance data using probabilistic sampling for species of special concern, especially for species suspected to be regionally rare or declining. A third objective for these inventories was to evaluate different methodologies for potential use in long-term monitoring activities.

The Principal Investigator of the project was Dr. Bruce Bury, a herpetofauna specialist and regional expert with the USGS. In the 2002 field season, four parks were sampled: Whiskeytown, Lava Beds, Oregon Caves, and Crater Lake. Redwood and Lassen Volcanic were sampled during the 2003 field season. In 2002, the sampling was stratified by major habitat type (terrestrial, pond/lake, and stream) and sites were selected randomly. The

methodology depended on the target species and the habitat, but included time constrained searches, visual encounter surveys, a headwater stream protocol for cold, rocky streams, and linear hikes. The field crew sampled 126 sites overall in the parks. The most frequently used methodology was time-constrained searches of terrestrial habitats.

The highest number of species, 22, was detected in Whiskeytown. Whiskeytown is characterized by steep elevational and climatic gradients, resulting in a great diversity in habitats, vegetation types, and aquatic systems. Both high elevation, cool climate species and low elevation, hot climate species are found in Whiskeytown. Of particular note were several new populations of tailed frogs found in cold, rocky streams flowing off Shasta Bally.

During the 2003 field season, the crew visited Crater Lake twice in mid to late summer. The purpose was to survey perennial streams to supplement the earlier terrestrial searches. A stratified, random sample of streams was inventoried using either a headwater or largewater survey methodology. The field crew targeted the Cascades frog (*Rana cascadae*) in the large water surveys. They targeted the coastal tailed frog (*Ascaphus truei*) and the Southern torrent salamander (*Rhyacotriton variegates*) in the headwater surveys. The surveys detected 5 species of amphibians and 1 reptile species in 16 sites. In addition, in 2004 a team of four people spent a week conducting additional inventories at 11 sites in Redwood. That effort documented 16 species.

The herpetological surveys were short duration efforts that provided documentation of species in the parks, but did not produce effective distribution and abundance information. The datasets included UTMs, environmental site data, and species data. The inventory team produced an annual report for the first year and individual reports for Redwood and Crater Lake. A report evaluating different methodologies used at Redwood, including potential methodologies for long-term monitoring efforts, was also produced. Reports, datasets, and images are on file at the Klamath Network office.

*Reports:*

Bury, R.B., L.C. Gangle III, and S. Litrakis. 2002. Inventory for Amphibians and Reptiles in the NPS Klamath Network: Annual Report 2002. 10 pp.

Bury, R.B., and E.J. Hyde. 2004. Monitoring Amphibians at Redwood National Park: Design, Detection Issues and Sampling Techniques. 29 pp.

Bury, R.B., and E.J. Hyde. 2004. Amphibian and Reptile Inventory and Monitoring: Redwood National Park. 26 pp.

Bury, R.B., and W. Wegner. 2005. NPS Klamath Network: Initial Surveys for Amphibians and Reptiles at Crater Lake National Park 2003. 26 pp.

**E. Lassen Volcanic Fish and Amphibian Inventory**

All of the parks but Lassen Volcanic previously met the 90 percent threshold for freshwater fish species. The Klamath Network fish inventory consisted of targeted surveys in this park. The

first objective of this inventory was to document the complete fish fauna in Lassen Volcanic, and the second objective was to gather baseline information on relationships between fish and native amphibians in lentic habitats. The relationships of native and non-native fish and amphibian species are a conservation concern in this region.

The study was a collaborative effort between Southern Oregon University and Redwood Sciences Laboratory, and it tied into a larger regional effort by Redwood Sciences Laboratory and other agency partners. Surveys were conducted during the summer of 2004, and were analyzed along with data collected in 2002 in two nearby wilderness areas, Thousand Lakes and the Caribou Wilderness. The field crew conducted visual encounter surveys of amphibians to collect data on presence, species, life stage, and relative abundance. For fish, the crew used timed gill net sets or visual surveys to identify the presence/absence of fish species and to measure relative abundance. The crew also collected habitat data. The surveys detected several species of amphibians and provided data on the distribution of native and non-native fish species.

The study produced datasets of species encounters and environmental data, including spatial data, and reports including maps of populations, estimates of species distribution and abundance in lakes, and a discussion of the ecological relationships between fish and amphibians in the region. These products are on file at the Klamath Network office.

The study confirmed that the Lassen Volcanic populations of Cascades frog (*Rana cascadae*) have declined dramatically since the mid-seventies, when abundant numbers of the frog were documented. In this study, the Cascades frog was only detected at three sites, which was not enough to allow statistical analysis. The frog is believed to be at immediate risk of regional extirpation. The presence of non-native fish is considered a potential driver of these population declines, but the scientists conducting the study at Lassen Volcanic believed that it was not a primary factor in the species' decline.

The study also included the creation of models that described the effects of fish stocking practices in the park. Fish stocking ended in the mid-seventies. The survey found that most lakes that were stocked historically have reverted to a fishless condition. Of the populations that persist, these populations are now self-sustaining and are expected to continue into the future. The researchers found that the factors driving whether lakes continued to support fish populations or not depended on elevation, size (perimeter) of the lake, and on the number of inlets in the lake.

The project included a related study of fish effects on invertebrates conducted by Dr. Michael Parker of Southern Oregon University. The agreement has been extended to February 2007 to allow an extra field season on the invertebrate component of the study. The preliminary results of the invertebrate data have raised extra research questions about interactions between fish and invertebrate species such as fairy shrimp, and having another summer field season will allow the PI to collect the data needed to address those questions.

*Reports:*

Stead, J.E., H.W. Welsh, Jr, and K.L. Pope. 2005. Census of Amphibians and Fishes in Lentic Habitats of Lassen Volcanic National Park: a Report to the National Park Service 2005. 77 pp.

**F. Birds**

The parks in the Klamath Network approached the 90 percent threshold at the beginning of the bird inventory effort. Data mining and cooperative bird census efforts were planned to allow all the parks to meet the goal of having 90 percent of their species documented. Inventory efforts were further justified by concerns about declining populations of neotropical migratory songbirds in the region. The inventories were conducted by the Klamath Bird Observatory (KBO). KBO administers the Klamath Demographic Monitoring Network, a partnership of federal, state, and private entities which conducts long-term bird demographic monitoring stations on public lands in the Klamath Region.

The objectives of the bird inventory were to establish bird monitoring stations and to conduct avian inventories in all six parks of the Klamath Network; to generate data on the distribution, abundance, and productivity of bird species in the region; to generate baseline data for eventual long-term monitoring; and to conduct a search for reports and datasets from previous bird monitoring efforts conducted within the Network

The field surveys were conducted during the 2002 and 2003 field seasons. The crews used several monitoring techniques, and conducted censuses during both breeding and migration seasons to maximize the number of species detected. The study areas included riparian and adjacent upland habitats. The first season of work included breeding season bird censuses at Crater Lake and Whiskeytown, breeding and migration season constant effort mist netting efforts at Oregon Caves, and migration season census efforts at Lava Beds. The species that were detected were checked against the Network's current inventory lists. The crews also compiled a brief summary of other datasets from previous bird monitoring efforts at Crater Lake and Redwood.

The censuses conducted by KBO confirmed many species on existing park hypothetical lists, and also added new species at all the parks. KBO detected and confirmed more than 100 bird species at Crater Lake National Park and Whiskeytown National Recreation Area in breeding season censuses. Forty-nine species were detected at a constant-effort mist-netting station established at Oregon Caves. Fifteen of those species were added by operating the station during both the breeding and the migration seasons. Area search censuses at Lava Beds detected 26 species, and a third of those were new to the park list. The number of species recorded was increased by the use of more than one inventory method at each park, and by the inclusion of both breeding season and migration season data. The analysis showed that the number of species detected was doubled if 10 census routes were used instead of 1.

The products include the annual report for the 2002 point count inventories, and tabular datasets with spatial data for both years. KBO submitted regional reports for 2003 that included all their survey sites, including sites on other agency and private lands; these reports place the Klamath Network data into regional context and provide information about regional patterns of bird

distribution, abundance, and species richness. The Network has also requested a report summarizing the 2003 data for just the Network monitoring sites.

*Reports:*

Alexander, John D. 2003. 2002-2003 National Park Service Klamath Network Landbird Inventory: 2002 Interim Report. Klamath Bird Observatory. 23 pp.

# CHAPTER FOUR: DATA REVIEW AND CERTIFICATION

## 4.1. REVIEW

Both the products of data mining and field inventories underwent review, but the bulk of the effort went towards certifying the park species lists. In terms of review, the data miners conducted quality checks to verify entered data against the hard copy data as they worked. They also assisted with data validation by watching for entries that looked erroneous. At the beginning of data mining, the Data Manager validated batches of entered data before sending them to WASO for upload to the online version of NPSpecies. When the data miners switched to the online format, validation was conducted by the Klamath Network Data Manager and park staff during the certification process.

For field inventories, Network and park staff examined drafts of reports produced by the project Principal Investigators (PIs) in order to detect any unusual identifications or results. The PIs were responsible for data entry and quality control and quality assurance tasks. The PIs were also asked to examine park species lists and to notify the Network if they knew of species to add.

## 4.2. CERTIFICATION

The park species lists are cumulative lists of many years of observations and studies, including information about rare or vagrant species that only occasionally are detected. These lists are at risk of containing and perpetuating misidentifications, errors of omission or commission, and weakly substantiated records. The certification process was designed to improve and verify the quality of the species lists in NPSpecies.

The certification process documented that the species list and associated attributes for a taxa group in a park were reviewed by a local expert who knows the biology, nomenclature, and taxonomy of species in a park, in order to reduce the number of errors in the data. This was done by both park staff and regional experts such as the Klamath Bird Observatory and the CSU Chico Biological Sciences Herbarium. The final approval of species lists was done by park staff at all parks. The review was for completeness and accuracy. The certification process also included the process of filling in the associated attributes of each species. This included, in NPSpecies, the "Checklist Fields" (park status, abundance, residency, nativity, and cultivation) and the "Management Fields" (weedy plants, pest organisms, management priorities, and exploitation concerns). Not all fields were filled in for each taxon The date of certification was recorded in NPSpecies, to help users judge the currentness and accuracy of the lists. All the lists were certified after the initial effort of data mining and inventories. Additional certifications will occur as park boundaries change, after major events (natural or man-made) affect biodiversity in the park, or when additional inventory work or other projects make major additions or changes to the list.

A last, important facility of the NPSpecies database is its capacity for parks to use locally accepted scientific names. During the certification process, park staff could add a new species name that was used at the local level and link it to a historical or legacy scientific name from a reference or old voucher.

After the list was certified, the National I&M Program conducted additional procedures to check data quality. If no inconsistencies were found, the certification data was uploaded to NPSpecies. The final step in the certification process was for National I&M to save a copy of the certified database (as a "snapshot" of a park's species list for future reference).

The certification occurred on a park-by-park and/or taxa basis as data mining activities were completed, beginning in 2002 and continuing through the present. Currently, 34 lists out of 36 have been certified. All of the parks have the six species lists certified except for Crater Lake, which at the time of this report still needed to certify two lists (bird and mammal).

# CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

Most of the major activities of the Inventory Program of the Klamath Network were concluded by 2004. Phase II of data mining is ongoing, but the data mining needed for the biological inventories has been completed. For the most part, the inventory projects have been completed and the products are on file at the Klamath Network office. A few reports have yet to be submitted. These include the 2003 report from Klamath Bird Observatory and the aquatic vascular plant report. The report for the invertebrate portion of the Lassen fish-frog study will be due February 2007.

In the Inventory Study Plan, the Network listed the products it wanted from each inventory project. For the GIS portion of each project, the Network requested georeferenced datasets, GIS layers with the collected data contained in the attribute table. The products that the Network received from each project are more accurately described as tabular data (in spreadsheet or database form) with accompanying UTMs (some type of GPS waypoints or track lines). The Network has the option of converting the datasets into GIS layers. The decision whether to do so or not will depend on whether the layers are considered likely to be useful for future projects, and useful enough to justify the time required to convert the datasets.

Need to post IAR.

The Project Tracking database will continue to be useful as long as it is maintained and updated. In particular, links to reports will need to be updated in the event of changes to the network setup at the Klamath Network office. The database should also continue to be updated to allow quick responses to information requests.

The Klamath Network's inventory and mining efforts afforded the parks in the Network a large amount of new data concerning park species as well as a tremendous amount of new, solid, consistent documentation on park species.

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